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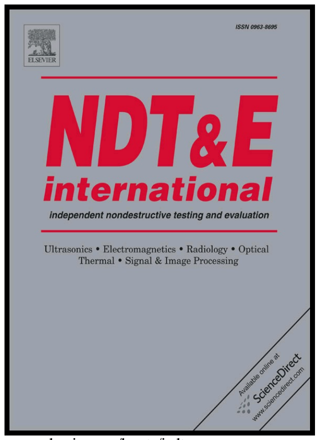

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Optimization of the pulse-compression technique applied to the infrared thermography nondestructive evaluation.

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Abstract— Pulse-compression infrared thermography is an emerging nondestructive testing and evaluation technique. An analysis of the main issues hampering the full exploitation of this technique is presented from both theoretical and experimental point of view and various strategies are introduced to overcome these problems and optimize the defect detection performance. A comparison between conventional pulse-compression thermography procedures and the proposed one is reported, using an LED modulated with a Barker sequence as coded excitation, and a carbon fibre composite benchmark sample containing artificial defects at different depths. The experimental results show that the suggested signal processing procedure assures a higher SNR and hence an improved defect detection capability. In addition, a time-analysis of such signals allows the correlation between the depth of defects and heat diffusion time to be more clearly identified.

Keywords—Nondestructive evaluation, Thermography, Coded Excitation, Pulse-compression, Barker Codes

I. Introduction

Active Thermography (AT) is a Non Destructive Testing (NDT) technique with application in various fields of research and analysis, ranging from diagnostic, material characterization to on-line and in-service inspection [1–6]. In particular, AT is applied extensively to the inspection of composite structures, and various measurement strategies have been developed to improve the technique [7–11]. Two main approaches have been pursued: time-domain analysis, with Pulsed Thermography (PT) as the most common method [12–15], and frequency-domain signals, with the single-frequency Lock-In Thermography (LIT) technique being the most popular [16–19]. The former approach provides more information than the latter. This is because a continuous frequency bandwidth is excited. On the other hand, by concentrating the signal energy within a limited set of excitation frequencies, use of a Lock-In produces improved levels of Signal-to-Noise Ratio (SNR) at the cost of less information. In recent years, many techniques have been developed in order to combine the advantages of both the above mentioned approaches, such as Pulsed-Phase Thermography (PPT) [4] and Multi-Frequency Lock-in Thermography (MF-LIT) [20].

Pulse-Compression Thermography (PuCT) is a recent technique developed by Mandelis *et al.* [21,22] and Mulaveesala *et al*. [23–25] in which the heating stimulus is in the form of a coded signal that has a unique